GROUP PROJECT DESCRIPTION

1. (OPTION A) [10.0] Consider a government **Capital Indexed Inflation Linked Bond** (ILB) with term sheet:

Notional amount	25000
Coupon Type	Fixed
Coupon rate	6.75%
Coupon frequency	Semi-annual
Currency	USD
Issue Date	31/7/2020
Maturity Date	21/7/2025
Trade Date	18/09/2020
Settlement Lag	T+1
Day Count	ACT/ACT
Inflation Reference Index	US Consumer Price Index
Inflation Reference Index Level at issue	237.14365
Inflation Reference Index Level at Settlement	251.14721

Assume the CPI index I_t follows a log-normal model (geometric Brownian motion), i.e.,

$$\frac{dI_t}{I_t} = \mu dt + \sigma dW_t,$$

where W_t is a Wiener process, μ the constant drift, and $\sigma > 0$ is the diffusion coefficient with estimates $\hat{\mu} = 0.05321$ and $\hat{\sigma} = 0.06358$. Assume there is no inflation indexation lag.

Assume that the issuers yield curve on the valuation date is given by the Nelson–Siegel-Svensson zero-coupon rate function parameters,

β_0	β_1	β_2	β_3	τ_1	τ_2
5.9%	-1.6%	-0.5%	1%	5	0.5

Tasks:

a) Compute the accrued interest.

b) Simulate 10000 scenarios for the inflation rate curve and CPI index.

c) For each scenario, calculate the ILB cash flows and estimate their fair value.

d) Estimate and analyse the inflation linked bond price distribution, including interest rate and inflation risk measures.

2. [10.0] An asset manager holds the following portfolio of fixed-rate Treasury bonds (delivering annual coupons, with a face value).

Bond	Maturity	Coupon rate (%)	Quantity
1	01/12/2025	4	10000
2	04/12/2026	7.75	250000
3	06/12/2027	4	50000
4	10/12/2028	7	100000
5	03/12/2029	5.75	10000
6	09/12/2030	5.5	200000
7	06/12/2032	4	15000
8	03/12/2035	4.75	10000
9	03/12/2030	4.5	30000
10	04/12/2045	5	75000
11	04/12/2050	4.5	100000
12	01/12/2051	4	10000
13	07/12/2052	5	10000

He wants to hedge it against yield curve shifts. Assume the spot market yield curve on the valuation date 09/02/2022 is well described by the Nelson–Siegel-Svensson (NSS) parameters:

β_0	β_1	β_2	β_3	τ_1	τ_2
5.9%	-1.6%	-0.5%	1%	5	0.5

He selected the following annual coupon paying Treasury bonds (with a €100 face value) as hedging instruments:

Hedging asset	Coupon rate (%)	Maturity
H1	4.5	12/04/2026
H2	5	28/12/2032
H3	6	06/05/2035
H4	6	10/10/2040
H5	6.5	10/10/2051

Tasks:

a) Compute the level, slope and curvature durations and $durations of target portfolio.

b) Compute the level, slope and curvature durations and $durations of the hedging assets.

c) Estimate the holdings of the hedging portfolio assuming the hedger wants to implement a self-financing (full) hedging strategy.

d) Assume that immediately after the hedging strategy was established, the yield curve changed and is now given by the following set of NSS parameters:

β_0	β_1	β_2	β_3	τ_1	τ_2
6.5%	-1.0%	0.1%	2%	5	0.5

i. Estimate the impact of this shift in the yield curve on the Target Portfolio assuming no hedging strategy had been implemented. Discuss the results.

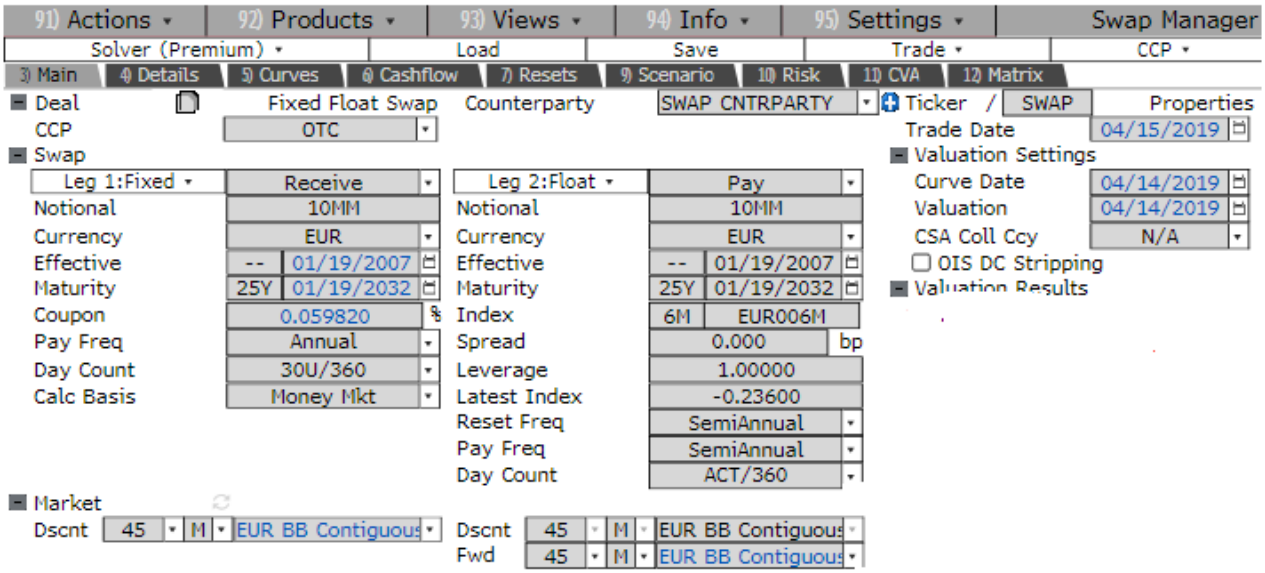
ii. Estimate the impact of this change in the yield curve on the global portfolio (target bond portfolio plus hedging instruments) and discuss the performance of the hedging strategy.

GROUP SIZE, PROJECT MILESTONES & REPORTS

The standard (and recommended) group size is 4. You are responsible for organizing your own groups. A single digital report with answers to all the above questions must be submitted by email to jbravo@novaims.unl.pt no later than January 26, 2024. Additionally, you are asked to send the Word & EXCEL & PDF & R Script / Python files used in the project.

INDIVIDUAL PROJECT DESCRIPTION

Consider the Bloomberg information on a 25-year fixed rate receiver **interest rate swap (IRS)** contract issued on 19-01-2007 with floating leg linked to EURIBOR 6-month rate.



Consider the Bloomberg reference EUR yield curve on the valuation date 14-04-2019 as detailed below. Based on the market information:

a) Build the complete yield curve using interpolation techniques.

b) Compute the accrued interest in the fixed and floating legs of the contract.

c) Calculate the clean (principal) and dirty market value of the swap contract.

d) Estimate the net present value of the contract.

e) Estimate the swap par rate.

f) Estimate the following IRS Greeks: present value of a one basis point shift (PV01), DV01, Gamma and discuss the interest rate risk of the contract.

Table 1. Bloomberg reference EUR yield curve on the valuation date 14-04-2019

Maturity Date	Market Rate (%)
15/04/2019	-0.36400
23/04/2019	-0.37800
16/05/2019	-0.36700
16/07/2019	-0.31000
16/10/2019	-0.23200
16/04/2020	-0.22700
16/10/2020	-0.19100
16/04/2021	-0.19925
19/04/2022	-0.13050
17/04/2023	-0.03975
16/04/2024	0.05525
16/04/2025	0.15425
16/04/2026	0.25650
16/04/2027	0.35725
18/04/2028	0.45825
16/04/2029	0.55240
16/04/2030	0.63850
16/04/2031	0.71650
17/04/2034	0.90100
18/04/2039	1.07100
19/04/2044	1.13400
20/04/2049	1.15200
16/04/2054	1.15000
16/04/2059	1.140249
16/04/2064	1.13100
16/04/2069	1.120999

PROJECT MILESTONES & REPORTS

This is an individual project. A single digital report with answers to all the above questions must be submitted by email to jbravo@novaims.unl.pt no later than January 26, 2024. Additionally, you are asked to send the Word & EXCEL & PDF & R Script / Python files used in the project.

GROUP PROJECT DESCRIPTION (

1. (OPTION B) [10.0] Consider a government **Capital Indexed Inflation Linked Bond** (ILB) linked to US monthly Consumer Price Index for All Urban Consumers (CPI-U) with term sheet:

Notional amount	25000
Coupon Type	Fixed
Coupon rate	6.75%
Coupon frequency	Semi-annual
Currency	USD
Issue Date	31/7/2020
Maturity Date	21/7/2025
Trade Date	18/09/2020
Settlement Lag	T+1
Day Count	ACT/ACT
Inflation Reference Index	US Consumer Price Index
Inflation Reference Index Level at issue (CPI)	256.389
Inflation Reference Index Level at Settlement	259.052

The CPI Reference Index for each settlement date, CPI_{Set}^{Ref}, is estimated as follows:

$$CPI_{Set}^{Ref} = CPI_{M-3}^{Ref} + \left(\frac{t-1}{D}\right)\left(CPI_{M-2}^{Ref} - CPI_{M-3}^{Ref}\right)$$

where:

M = calendar month in which the settlement date falls
t = day of the month in which the settlement date falls
CPI_{M}^{Ref} = Reference CPI of calendar month M
D = Number of days of the month in which the settlement date falls according to the day count conventions.

Assume that the issuers yield curve on the valuation date is given by the Nelson–Siegel-Svensson zero-coupon rate function parameters,

β_0	β_1	β_2	β_3	τ_1	τ_2
5.9%	-1.6%	-0.5%	1%	5	0.5

Minimum Tasks:

a) Compute the accrued interest.

b) Analyse the historical data and provide forecasts of the dynamics of the US CPI inflation index using a statistical learning, machine learning or time series model. The minimum forecasting horizon is the remaining lifetime of the bond. Provide point forecast and confidence intervals for the CPI estimates and discuss the model's goodness-of-fit and forecasting accuracy.

c) Estimate the ILB cash flows and compute the market fair value of the contract. Provide estimates of the confidence intervals for the price

d) Estimate and analyse the inflation linked bond price distribution, including interest rate and inflation risk measures.